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Erratum

Growth mechanisms for single-wall carbon nanotubes in a laser ablation process

C.D. Scott[1], **S. Arepalli**[2], **P. Nikolaev**[2], **R.E. Smalley**[3]

[1] EM2, NASA Johnson Space Center, Houston, TX 77058, USA
[2] GB Tech/Lockheed Martin, P.O. Box 58561, Houston, TX 77058, USA
[3] Center for Nanoscience and Technology, Rice University, Houston, TX 77005, USA

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The original paper [1] was published with an error in the estimate of growth rate of carbon nanotubes in the laser ablation process. The original paper indicated that for an estimated plume density of carbon of $10^{18}\,\mathrm{cm}^{-3}$, nanotubes grow at a rate of 100 μm/μs. This number is in error. The actual number should be 0.005 μm/μs, assuming a growth temperature of 1473 K. Therefore, to grow a nanotube to a length of a few microns it would take a few milliseconds instead of a few hundredths of a microsecond. This implies that growth must occur at lower temperatures, near the oven temperature, rather than in the hot ($\sim$ 4000 K) laser plume. As shown in the original paper, the temperatures measured by emission spectroscopy dropped to about 2000 K within about 50 μs. Farther from the target, in the mixed region of the laser ablation tube, the temperature drops to the oven temperature within about 5 μs of the laser pulse. In that region the lasers may ablate suspended carbon clusters to form feedstock for further nanotube growth.

A corroboration of this estimate can be obtained from atomic force microscope measurements [2] of the length of nanotubes and the time available to reach a witness plate (growth time). Single SWNTs were observed to be at least 25 μm long. The time of about 1 ms to reach the witness plate was estimated from the plume expansion speed. A lower estimate of SWNT growth rate is 25 μm/1 ms = 0.025 μm/μs. This estimate is within a factor of 5 of the kinetic estimate. Thus, they are in fairly reasonable agreement. The average speed of growth in the original paper was 0.15 μm/μs, because of the assumption that the plume expands with a constant rate of $\sim$ 100 m/s. That is only true for the first few microseconds, but the plume slows down quickly, as can be seen in ICCD images.

References

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